MEA

soil moisture and climate monitoring with certainty

Soil Moisture Sensor

Installation Guide

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Notices

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Design Changes

Measurement Engineering Australia Pty. Ltd. reserves the right to change the designs and specifications of its products at any time and without prior notice.

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Warranty

MEA offers a 12 month, **return-to-factory** warranty on all products*. The warranty applies to hardware, software and system defects only. The warranty does not cover acts of misuse by the user or third parties, including misuse arising from failure to install or operate a system or its components in accordance with relevant system documentation, or failure to seek advice from MEA regarding correct installation or operation of a system or its components.

*EnviroPro probes have a 5 year warranty. ThetaProbes have a 2 year warranty.

Support

If you have questions or problems that cannot be resolved using the information in this manual, contact MEA technical support using the details above. If phoning, ask for technical support and explain the issue. Your issue will be referred to a technician for action at the earliest opportunity. Quoting your MEA Job Reference Number will enable us to quickly locate your details. Charges may apply for support other than warranty support.

Phone support is generally available Monday to Friday between 9 am and 5 pm Central (ie South Australian) Standard or Summer Time.

Site visits will incur charges for labour, travel time and where applicable, accommodation and meals.

MEA technicians can only offer support for issues relating directly to the operation or maintenance of products supplied by MEA.

Contents

Introduction

Thank you for purchasing a soil moisture sensor from MEA. This guide tells you how to install your soil moisture sensor correctly.

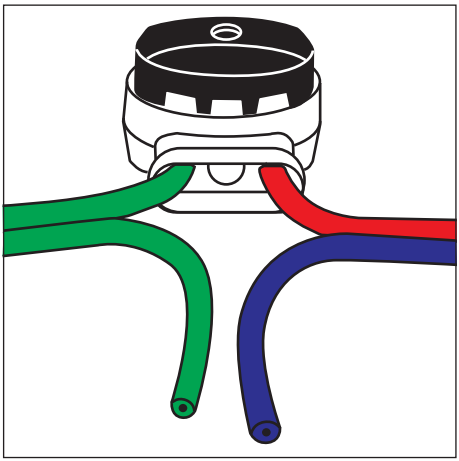
For information on how to install, operate and maintain other components of your soil moisture monitoring system, please refer the User Manual or System Document that was supplied with your system.

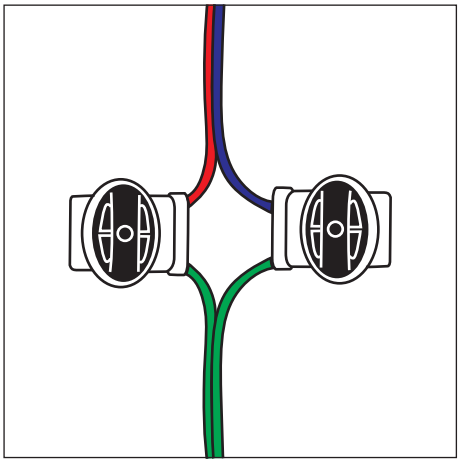
How to Use Scotchloks

Many (but not all) of the soil moisture sensors discussed are connected to measuring equipment using low voltage irrigation connectors. 3M® 316IR Scotchloks can be used for this purpose. If you have not used Scotchloks before, the following notes will be of use:

- Use one Scotchlok per join. There are three holes - use one for a sensor wire and one for a measurement equipment wire - **leave the third hole unused.**
- Don't strip the insulation from the wires to be joined. The metal plates inside the connectors work by displacing the insulation. Stripping the insulation will result in a poor connection.

1. Push one wire from the sensor cable and the relevant coloured wire from the logger or field station into the connector as far as they will go. The connectors are translucent on the side opposite the black button so you will be able to see when the wires are all the way in.
2. Holding the wires in place, use pliers or multi-grips to push the black button on the connector all the way down.
3. Repeat for all remaining connections.
4. After all the blocks are connected, ensure that the end of the logger cable is off the ground and pointing downward so that water is not able to collect in the cable. For added protection you can wrap the end of the cable or the join itself in waterproof tape.





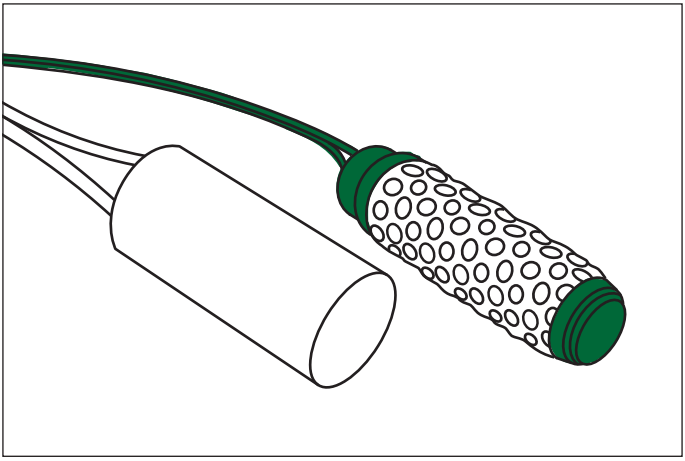
A Note on Augering Tolerances

Augered holes need to be slightly larger than the sensor installed in them to allow the insertion of the sensor. However, holes should not be too large or air-gaps can exist between the sensor and the surrounding soil. Sensor-to-soil contact can be improved by the use of slurries to fill the gaps. In the case of the bentonite clay and fine sand slurry recommended for some probes in this manual, too much slurry can negatively affect the quality of the readings.

The following method may help you create a clean tight-fitting hole that minimises air gaps and minimises the amount of slurry required:

1. Remove the topsoil at the installation site using a post-hole auger, shovel or other tool. Neatly pile the topsoil nearby.
2. Use an under-sized auger (eg a gypsum block auger in the case of EnviroPro or AquaCheck installation) to drill a pilot hole to the required depth.
3. Finish the hole using the auger recommended on the 'Required Tools and Equipment' list for the relevant sensor.
4. Install the sensor.
5. Carefully replace the topsoil. Firm the topsoil down to remove air pockets.

Gypsum Blocks



Gypsum blocks are a type of soil moisture tension sensor. They report soil moisture in kilo pascals (kPa). Gypsum blocks can be used with:

- Plexus radio networks for continuous monitoring and viewing of data on your PC or smart device.
- MAX soil moisture loggers for continuous monitoring and viewing of data on your PC.
- GDot for 'spot' monitoring (GBLites only).

MEA's **GBHeavy** measures over the range of 50 to 500 kPa (the range found in heavy soils having a high clay content).

The **GBLite** (also known as the Watermark) measures over the range of 10 to 200 kPa (sand to sandy clay loam).

Which Type of Gypsum Block is Suitable?

if moisture levels are to be kept in the range where it is readily available to the plants, use the GBLite regardless of soil type. Where the crop is going to be pushed into deficit, use the GBHeavy in soils with a substantial clay content and the GBLite in sandy soils. The GBHeavy sensor also makes an inexpensive drainage detection sensor when used below a set of GBLites.

Sensor Site Selection

The following section relates specifically to the placement of gypsum block sensors under different types of irrigation, but the principles will apply more broadly to other types of soil moisture sensor.

Drip Irrigation

Install the sensors at the edge of a 10 ~15 cm radius centred under the dripper.

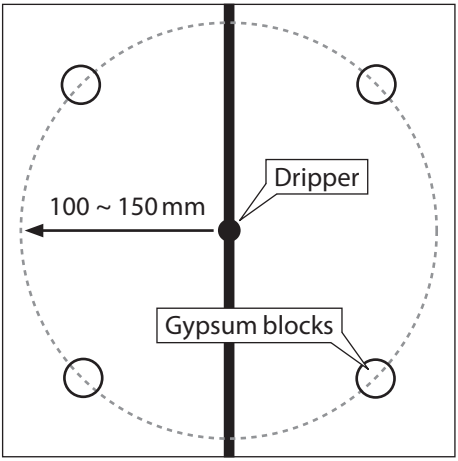


Fig. 1. Place the blocks in a circle around the dripper as shown.

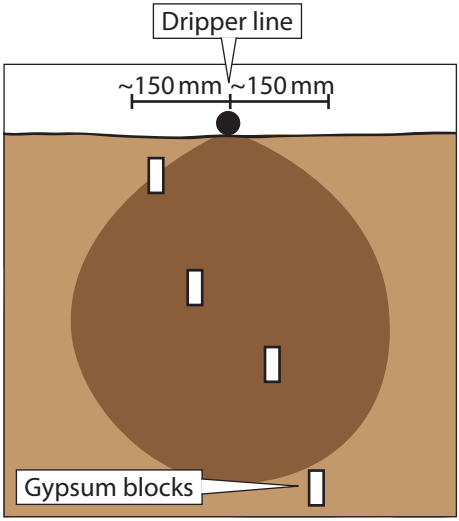


Fig. 2. Place the blocks through the 'wetting onion'. The deepest block serves as a 'drainage' sensor.

Hint: If you have more than one gypsum block, install each block in its own hole. Stacking sensors in the same hole can lead to leakage down the hole, and makes it impossible to replace deeper blocks if later required.

Sprinklers

Install the sensors in a straight line 10cm apart, in a location where the sprinklers are delivering their rated output. Under tree crops place the blocks under the drip-line of the canopy.

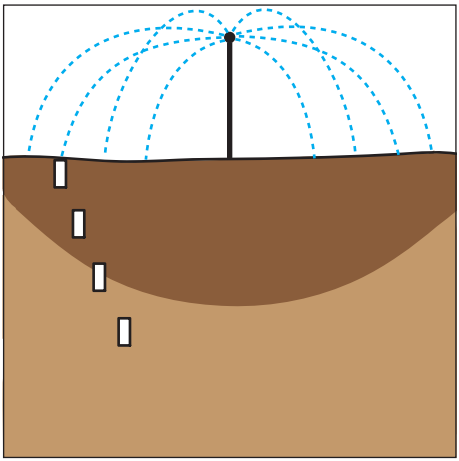


Fig. 3. Gypsum blocks under sprinklers.

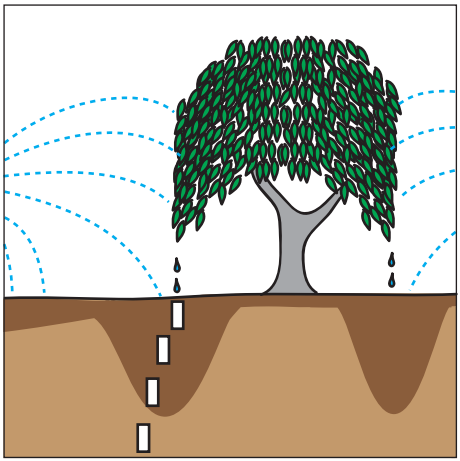


Fig. 4. Under sprinkler-irrigated tree crops, place the blocks under the drip-line of the canopy.

Furrow or Flood Irrigation

Locate the sensors about 2/3 of the way down the run, just ahead of the tail or backup water. This is the area where water penetration is usually the poorest. With tree crops, locate the sensors on the side of the tree that will get the hot afternoon sun.

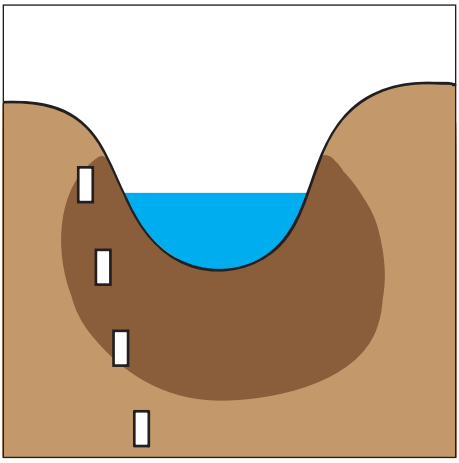


Fig. 5. Placement of gypsum blocks under furrow irrigation.

Centre Pivot or Linear / Lateral Move Irrigation

Place the blocks at locations down the length of the pivot (between towers) just ahead of the "start" point.

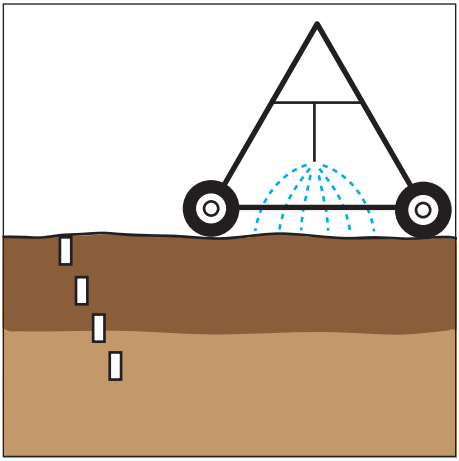


Fig. 6. Placement of gypsum blocks under pivot irrigation.

Required Tools and Equipment

- 25mm Auger (MEA2193).
- Masking tape or electrical tape.
- 13mm (½") PVC pressure pipe, 1.2m in length (or about 300 mm longer that the depth of the deepest block you are going to install).
- 12mm dowel (about 100 mm longer than the PVC pipe).
- Trowel.
- Bucket & water.
- Two small funnels.
- Bentonite (civil grade eg Unimin Active Gel 150) (MEA2197, 2kg pack will cover 15 - 20 sensors).

Hint: Use only powdered active-gel bentonite. Bentonite is also sold in granulated form - granulated bentonite is unsuitable for sensor installation.

- Fine dry builder's sand eg Unimin AFS85 grade- 8 kg to mix with 2 kg of bentonite.
- Tape measure, notebook, tags & permanent marker.

How to Install Gypsum Blocks

1. Pour a couple of litres of clean water into the bucket, and place the gypsum blocks in to soak.

Hint: If the blocks are GB Heavies, remove the foil wrapping first.

It is enough to soak the blocks for one to five minutes. Do NOT soak the blocks for long periods (eg overnight) as this will shorten their usable life.

2. Make a dry 1-part bentonite to 4-parts sand mix. Two kilograms of bentonite mixed with eight kilograms of sand will make approximately enough to install sixteen gypsum blocks (depending on the installation depths and augering tolerances).

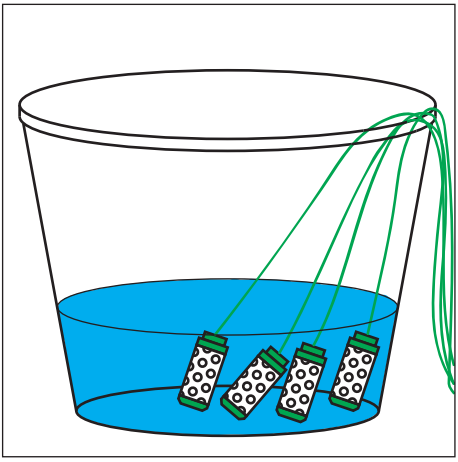


Fig. 7. Soak the blocks.

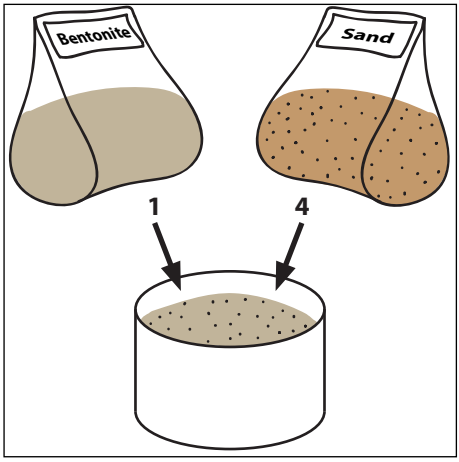


Fig. 8. Mix the bentonite and sand.

Hint: The bentonite / sand mix forms a plug that prevents water running down the disturbed soil in the hole and making the blocks wetter than the surrounding soil.

3. Mark the auger and the PVC pipe with tape at the installation depths. Treat the mid-point of a gypsum block as the sensing point when working out depths.

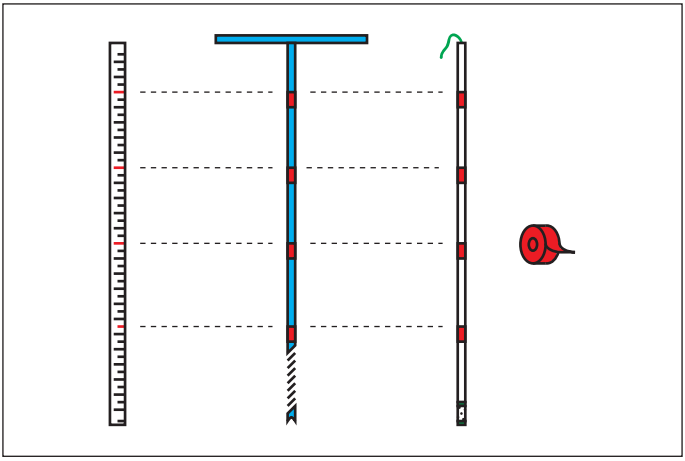


Fig. 9. Mark the auger and pipe with the installation depths.

Hint: When marking the PVC pipe, remember to allow for the length of the sensor.

4. Auger the first hole. Remove the auger to clean the flukes frequently.

Hint: Put the soil removed from the hole in its own pile. You will use it to help seal the sensors.

5. Pour half a cup of water down the hole to ensure correct seating of the sensors.

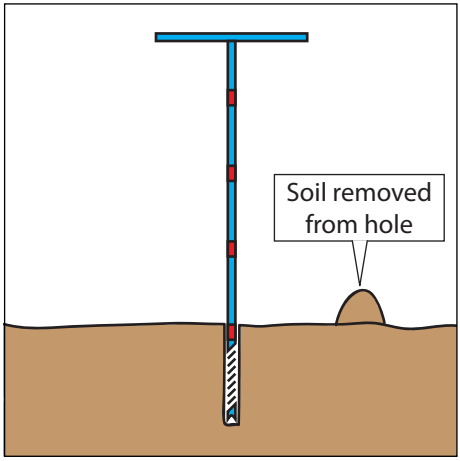


Fig. 10. Auger a hole.

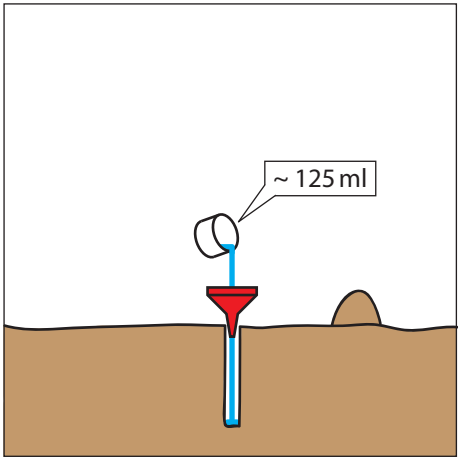


Fig. 11. Wet the hole.

6. Push the sensor cable through the pipe from the bottom. Hold the cable taut and use the pipe to gently push the sensor into the hole. Use the marks on the pipe to ensure the sensor is at the intended depth.

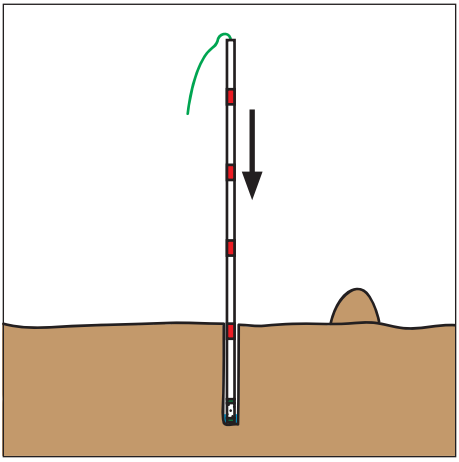


Fig. 12. Use the PVC pipe to insert the gypsum block in the hole.

7. Withdraw the pipe. Pour a handful of earth down the hole and gently compact with the dowel.

8. Add the bentonite and sand mix and backfill the hole to 25 mm from the top.
9. Use more earth to complete filling the hole.

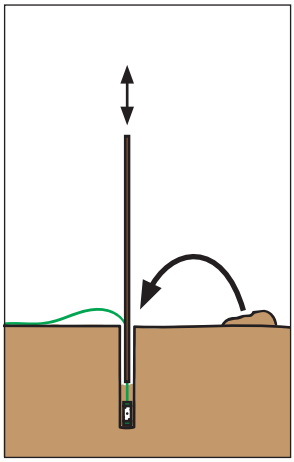


Fig. 13. Add earth and tamp.

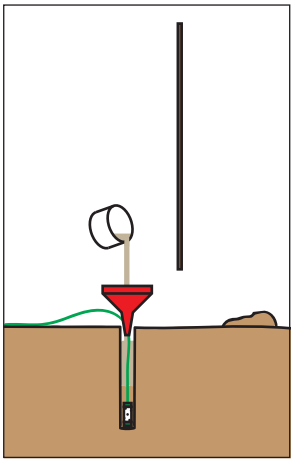


Fig. 14. Add the bentonite and sand mix.

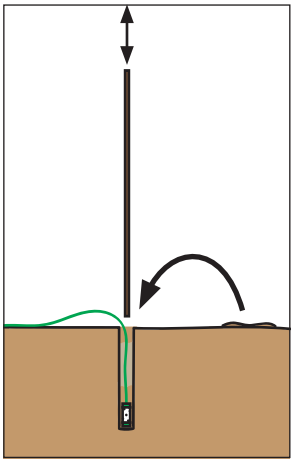


Fig. 15. Cap the hole with earth and tamp.

10. Use the permanent marker to label the sensor wire with the depth, installation date and sensor number (a cattle tag can be used for this).

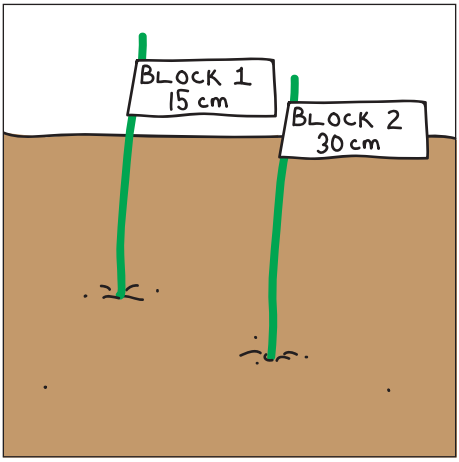


Fig. 16. Mark the cables with the block number and depth.

11. Connect the sensor to the logger or display.

Installing GBLites in Shallow Root Zones

In many vegetable crops the root zone is very shallow – under 20 cm. The active feeder roots of citrus, particularly when grown in sandy soils can also be quite shallow. GBLite sensors can be installed at shallow depths by laying the sensor horizontally in a hole opened up with a spade or trowel. Wet the bottom of the hole, and carefully backfill with moist soil, gently compressing the soil to remove air pockets.

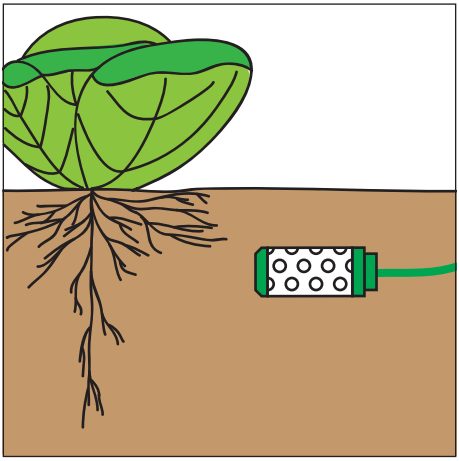


Fig. 17. Sensor laid on its side to monitor shallow-rooted crops.

GTBug Temperature Sensor

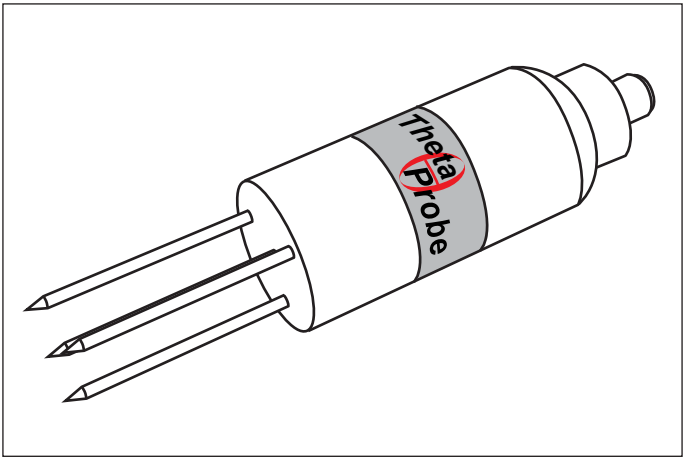
The temperature sensor should be installed between 100 mm and 150 mm where daily fluctuations in surface temperature are minimised. This sensor can simply be placed in a hole of the correct depth and backfilled, gently compacting the soil as you go.

Improving the Sensor-to-Soil Contact

In reactive clay soils and in light sands, the installation procedure can be modified to improve soil to sensor contact. This avoids problems with clay soils shrinking away from the sensors or with sandy soils drying down faster than the sensor can respond. Before installing the sensor:

1. Make a 50 / 50 slurry of water and clay-loam sourced from elsewhere on site (if available.
2. Coat the sensor in a thin layer of slurry, then install.

ThetaProbes



ThetaProbes are a type of soil moisture content sensor. The probe consists of a waterproof housing containing electronics with an array of stainless steel electrodes at one end (for direct insertion into undisturbed soil) and a power/signal cable at the other.

ThetaProbes measures soil moisture content with an accuracy of ± 1% over the range of 0 to 60% of volumetric soil moisture content. This level of accuracy makes the probe suitable for use where soil moisture levels are to be tightly controlled, and in critical applications such as hydrology, soil stability studies, soil water profiling, pollution monitoring, water leakage detection from pipes and dams, ground-truthing and forestry.

ThetaProbes can be used with:

- MEA's MAX soil moisture loggers for continuous monitoring and viewing of data on a PC.
- HH2 Reader to provide 'spot' measurements that can be downloaded to a PC.

Sensor Site Selection

Please see "Sensor Site Selection" on page 9. Although this section deals with the placement of gypsum blocks under different types of irrigation, the considerations apply equally well to ThetaProbe sensors.

Required Tools and Equipment

Surface Installation

- Soft ground - no tools are required.
- Hard ground - a ThetaProbe insertion kit and a hammer.

Buried Installation

- Spade or trowel for shallow installation.
- 45 mm Auger (MEA2192) for deeper installation.
- 32 mm (1¼") PVC pipe or similar, 300 mm longer than the deepest installation depth.
- 12 mm dowel, ~ 100 mm longer than the PVC pipe.
- Active Gel Bentonite (civil grade eg Unimin Active Gel 150) (MEA2197).
- Dry builder's sand - 4 times the quantity of bentonite.
- Tape measure, notebook, tags, permanent marker or tape for marking.

How to Install ThetaProbes

Surface Measurement

- For surface measurement the stainless steel rods can just be pushed into **undisturbed** soil.

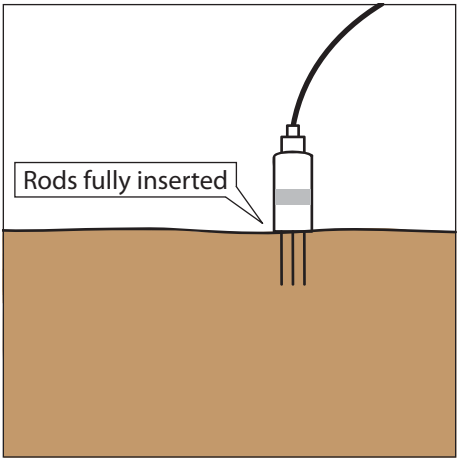


Fig. 18. Surface measurement with a ThetaProbe.

Hint: Make sure the stainless steel rods are completely covered. If any part of the rods are uncovered, soil moisture readings will not be accurate.

- If the probe is going to be left in place, it is a good idea to insert it at a slight angle (eg 10°~20°) so that water running down the outside of the probe is less likely to pool around the rods.
- Try to ensure there are no air pockets or stones around the electrodes as this will reduce the quality of the measurements.

Take care not to bend the rods. Do not handle the probe by its cable. Repairs can be costly and time-consuming.

- In hard ground, use of the ThetaProbe Insertion Kit is recommended:
  - Place the guide block on the ground at the sampling location.
  - Place the preparation rods into the holes in the guide block and gently tap them into the soil until the heads contact the guide block.
  - Withdraw the guide block and preparation rods and insert the probe.

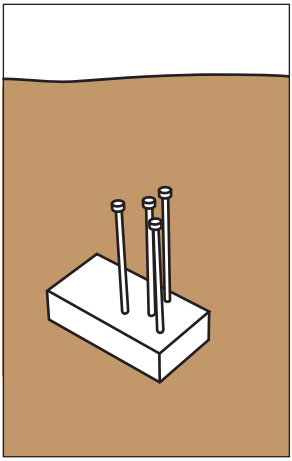


Fig. 19. Fit the pins to the guide block.

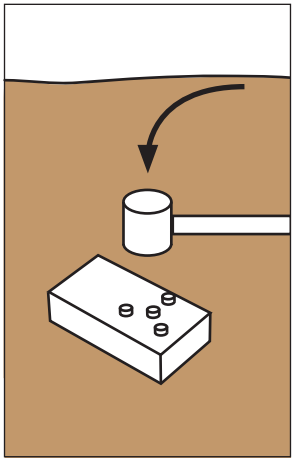


Fig. 20. Hammer the pins in.

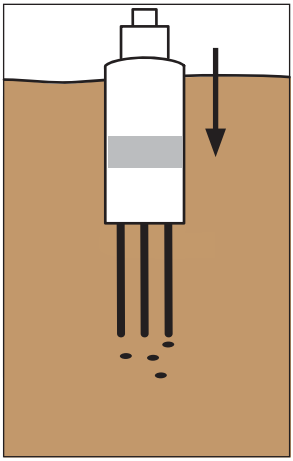


Fig. 21. Push the probe into the holes.

Buried Installation

The need to monitor a particular part of the root zone can require a buried installation. Even with a shallow installation, it might be preferable to bury the probe to provide protection for it. ThetaProbes can be installed either horizontally or vertically depending on the depth of installation and installation equipment available.

How to Install a ThetaProbe Horizontally

The probes may be installed horizontally in shallow sites. The sensor should be inserted into **undisturbed** soil on the face of the trench:

1. At the monitoring site, excavate a trench down to 10 cm below the intended sensor depth. Clean off the face of the hole at the required depth.
2. Push the rods into the side of the hole until the soil comes in contact with the probe body.
3. Route the sensor cable out of the hole to the surface (it can be sheathed in conduit to protect it against damage).
4. Carefully backfill under and around the sensor.

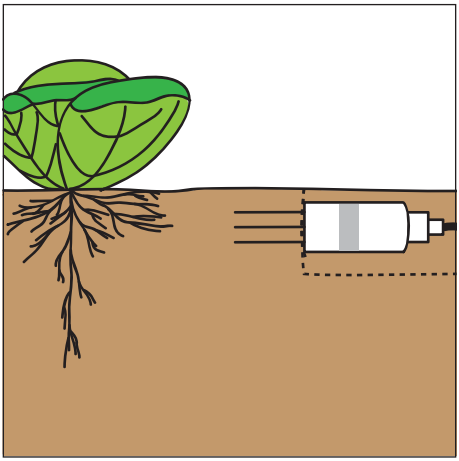


Fig. 22. ThetaProbe installed horizontally.

How to Install a ThetaProbe Vertically

1. Use the marker or tape to mark the auger and the PVC pipe with the installation depth(s).

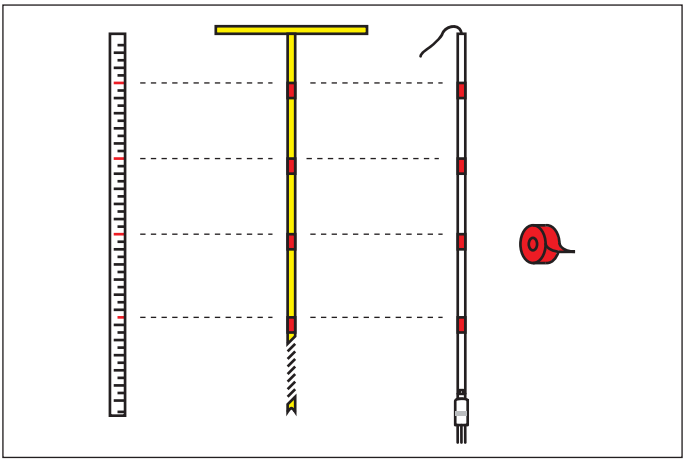


Fig. 23. Mark the auger and pipe with the installation depths.

Hint: When marking the PVC pipe, remember to allow for the length of the sensor.

2. Make a dry 1-part bentonite to 4-parts sand mix.

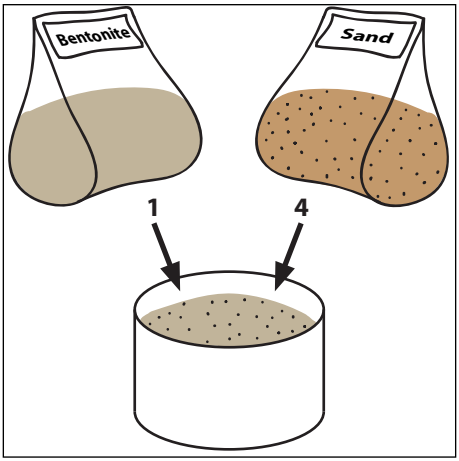


Fig. 24. Mix the bentonite and sand.

3. Auger a hole.

Hint: It is recommended that the hole be augered approximately 10° off vertical to help prevent water pooling at the rod array.

4. Thread the probe cable and connector (if fitted) through the PVC pipe and use this to push the sensor down the hole, pushing the rods into the undisturbed earth at the bottom of the hole. Take care not to bend the rods.

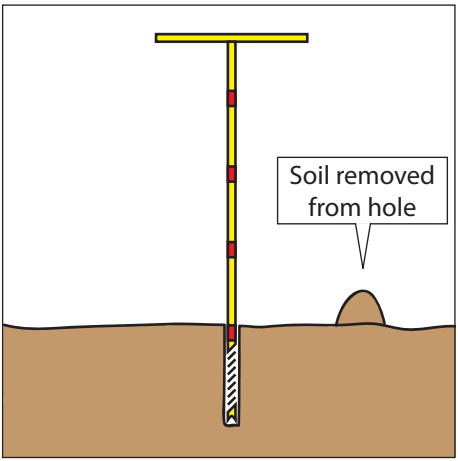


Fig. 25. Auger a hole.

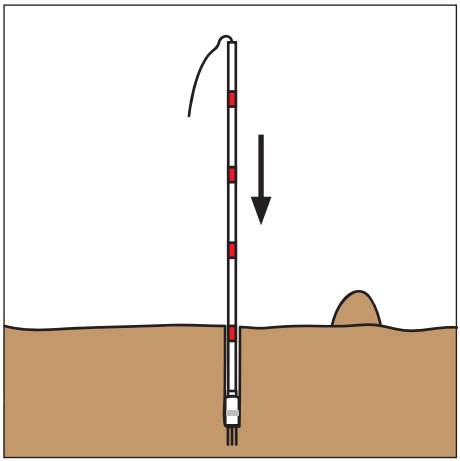


Fig. 26. Use the PVC pipe to insert the ThetaProbe into the hole.

5. Pour a handful of earth down the hole and gently compact with the dowel.
6. Fill the hole to 25 mm below the surface with the dry bentonite and sand mix, gently tamping as you go. Use more earth to complete filling the hole. Do not overfill as this will form a surface cap which will shed water away from the sensor.

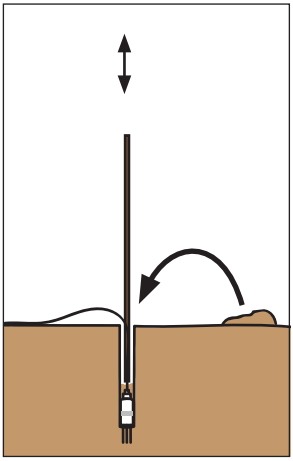


Fig. 27. Add earth and tamp.

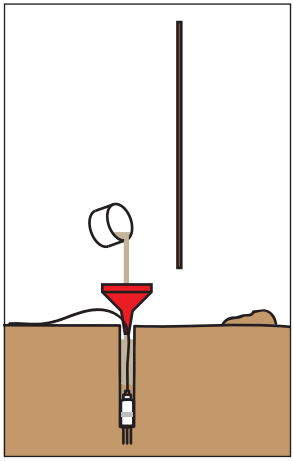


Fig. 28. Add the bentonite and sand mix.

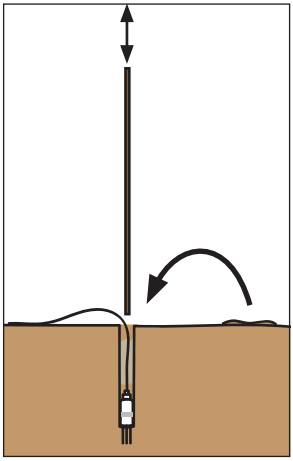
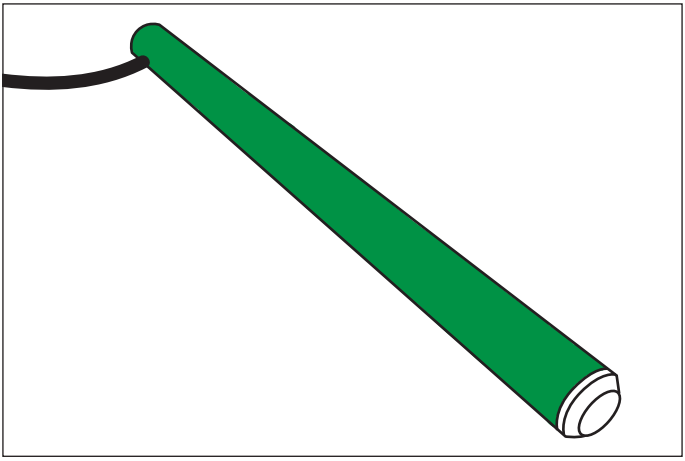


Fig. 29. Cap the hole with earth and tamp.

EnviroPro



EnviroPro probes provide reliable soil moisture, and temperature measurement in all soil types. Multiple sensor clusters per probe at 100 mm spacings allow the monitoring of moisture and temperature at each sensor depth. Models which add salinity measurement at each depth are available. Soil moisture readings are temperature-compensated and can be salinity-compensated.

The internal electronics are fully protected, making the probes reliable, consistent and very stable. The EnviroPro comes with a five-year warranty.

Each probe is supplied with 5 m of cable. Designed to be completely buried, the EnviroPro is 'out of the way' when slashing, spraying and harvesting.

Moisture profiling at 100 mm intervals allow you to track the movement of water through the root zone and optimise irrigation events. Following the movement of nutrients through the root zone by tracking changes in salinity allows you to optimise fertiliser applications and only apply leaching irrigations when needed.

EnviroPros can be used with:

- Plexus for continuous monitoring and the display of data on smart devices.
- MAX for continuous monitoring and viewing of data on a PC.

Which Probe to Use

The choice of probe will be determined by the depth of the root zone or profile depth to be monitored, and the parameters to be measured. All EnviroPro probes can measure soil moisture and soil temperature. EC equipped models also measure electroconductivity (EC) at each depth.

Model	Moisture	Temp	EC	Sensing Points	Length (cm)
EP04	✓	✓	-	4	46.5
EP08	✓	✓	-	8	86.5
EP12	✓	✓	-	12	126.5
EP16	✓	✓	-	16	166.5
EPEC04	✓	✓	✓	4	46.5
EPEC08	✓	✓	✓	8	86.5
EPEC12	✓	✓	✓	12	126.5
EPEC16	✓	✓	✓	16	166.5

Sensor Site Selection

Please see "Sensor Site Selection" on page 9. Although this section deals with the placement of gypsum blocks under different types of irrigation, the considerations apply equally well to EnviroPro sensors.

Required Tools and Equipment

- 36 mm Auger (MEA2189).
- Tape measure.
- Permanent marker or tape for marking.

The Probe Must Be Installed in A Slurry

EnviroPro sensors are installed in over-sized holes and a slurry mix must be used to ensure good sensor-to-soil contact. The two type of slurry recommended are:

- A soil slurry made of soil obtained from the hole itself and surrounds;
- A slurry made of a bentonite clay and fine sand.

How to Prepare a Soil Slurry

You will need:

- About 1 kilogram of clean soil to install two 80 cm probes.
- About 1 litre of clean water per kilo of soil.
- A means of sieving out rocks and organic matter from the soil.
- A bucket to mix the soil and water together in.
- A funnel to pour the mixture down the hole.

Method

1. Pass the soil through a sieve to remove any rocks and organic material.
2. Gradually mix in enough water to form a creamy paste.

How to Prepare a Bentonite / Sand Slurry

If the local soil is not suitable for the preparation of a slurry as described above, the EnviroPro should be installed using a fine sand and bentonite slurry.

The quantities and method described below will make enough slurry for the installation of two 80 cm probes.

You will need:

- One MEA2014 Bentonite and sand pack.
- 1L clean water.
- Small bucket with lid.
- Funnel.
- Two-litre plastic bottle with lid.

Method

1. Mix 100 gm of bentonite and 1 kg sand together in a bucket.

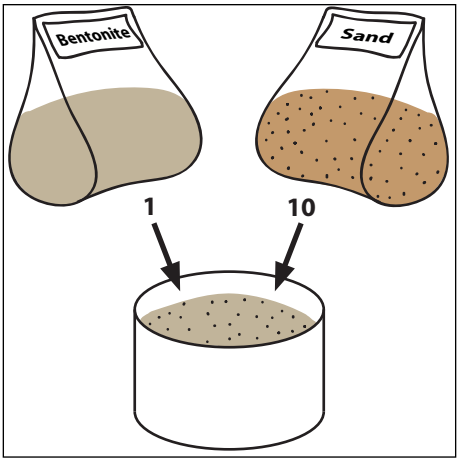


Fig. 30. Mix the bentonite and sand.

2. Pour the dry mix through a funnel into a two litre plastic bottle.
3. Pour 750 ml of clean water into the bottle.
4. Put the lid on and shake until thoroughly mixed. Allow 15 minutes for the bentonite to swell. The resulting mix should be a 'creamy' consistency.

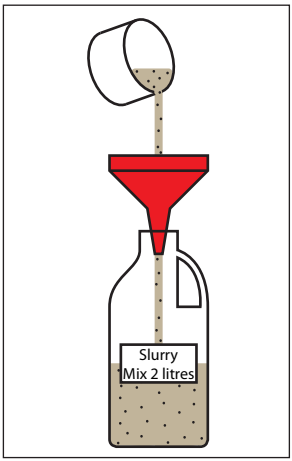


Fig. 31. Pour the dry mix into the container.

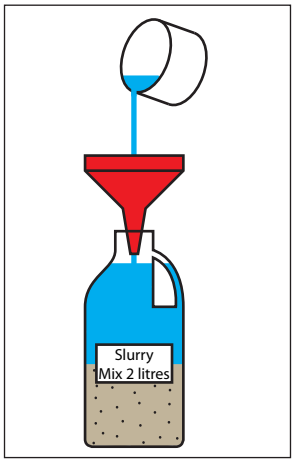


Fig. 32. Add the water.

Fig. 33. Shake until completely mixed.

Hint: Always shake the mixture before application (the sand might settle in storage).

How to Install EnviroPro Probes

1. Measure the length of the probe. Use the tape measure and the adhesive tape to mark the auger 3.5 cm longer than the probe to be installed.

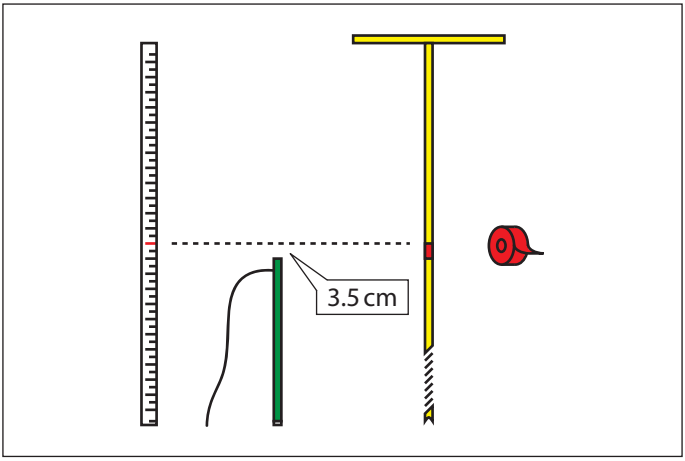


Fig. 34. Mark the auger 3.5 cm longer than the length of the EnviroPro.

2. Auger a hole 3.5 cm deeper than the probe to be installed. Use the tape measure to check the depth after the auger is extracted to ensure that part of the hole wall has not collapsed or that other material has not fallen into the hole.

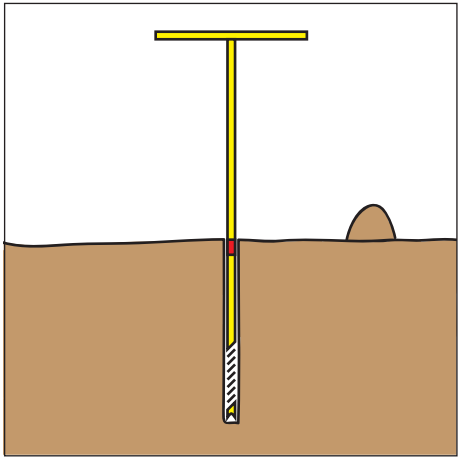


Fig. 35. Auger the hole.

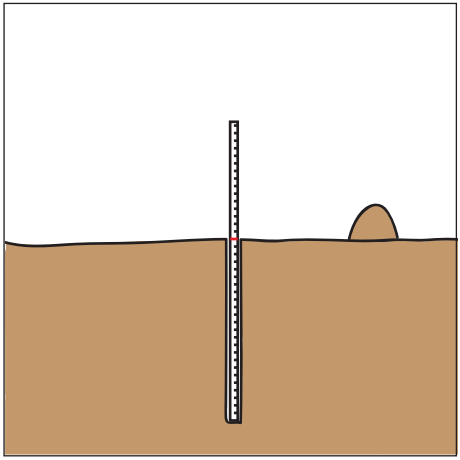


Fig. 36. Check the depth.

3. Pour slurry into the hole until it is half full.
4. Push the probe into the hole until the top is 35 mm below the soil surface. **Apply a maximum of 15 kg of force to the probe.** Avoid causing sharp bends in the cable where it enters the probe.

Hint: Assess the thickness of your slurry. Some resistance should be encountered when pushing the probe into the hole. If the probe is very difficult to push in, the slurry is too thick. Add 5% more water, mix and test. If the probe goes in too easily the slurry is too thin. Add 5% more bentonite/sand, mix thoroughly and leave for fifteen minutes before testing. Repeat this procedure until you are satisfied with the consistency.

5. The slurry should ooze up around the instrument and slightly overflow the hole. If you do not see any slurry, carefully extract the instrument, mix up some more slurry and add to the hole.
6. Backfill to cover the probe.

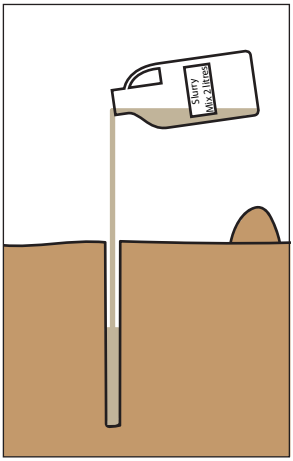


Fig. 37. Fill the hole half full of slurry.

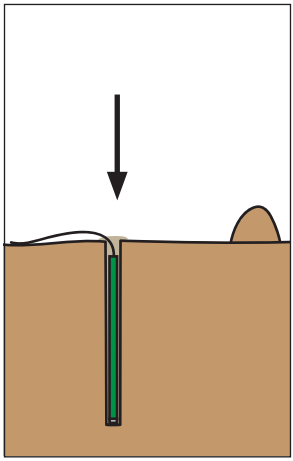


Fig. 38. Insert the EnviroPro.

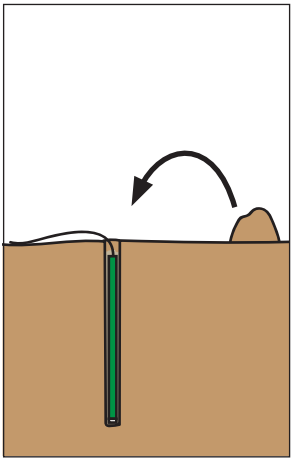


Fig. 39. Cap the hole with extracted earth.

7. Trench the cable in to a depth of 100 mm or deeper to protect it. Leave a loop of cable in the trench to provide 'strain relief' if the cable is snagged by machinery or stretched due to compaction of the ground.
8. Where the cable leaves the ground, consider placing it in protective conduit to prevent damage from animals or machinery.
9. Tie the cable to the post supporting the logger or Plexus unit using zip-ties.

How To Extract an EnviroPro

EnviroPro probes can be extracted using a purpose-built probe removal tool (available through MEA), or using multi-grips or vice-grips.

Extraction Using a Probe Removal Tool

1. If the soil is dry, extraction can be made easier by pre-wetting the soil the day before attempting extraction.
2. Use a trowel or small spade to carefully remove the soil around the head of the probe down to a depth of 15 cm.
3. Clamp the probe removal tool to the probe body 10 mm below the cable.

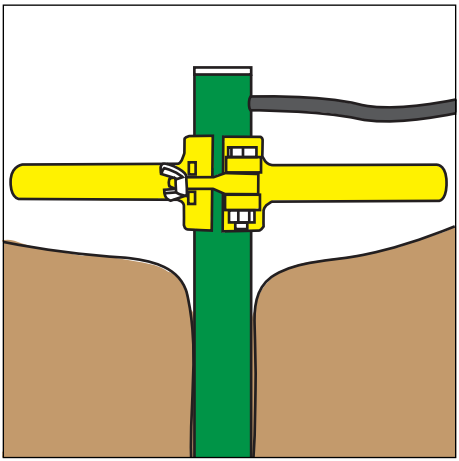


Fig. 40. Placement of the probe removal tool.

4. Grip the handles of the probe removal tool. Rotate the probe clockwise and anti-clockwise until you can rotate the probe approximately a quarter-turn.

Make sure the removal tool does not interfere with the probe cable.

5. You should now be able to work the probe free of the soil by pulling upward while continuing the rotating motion.

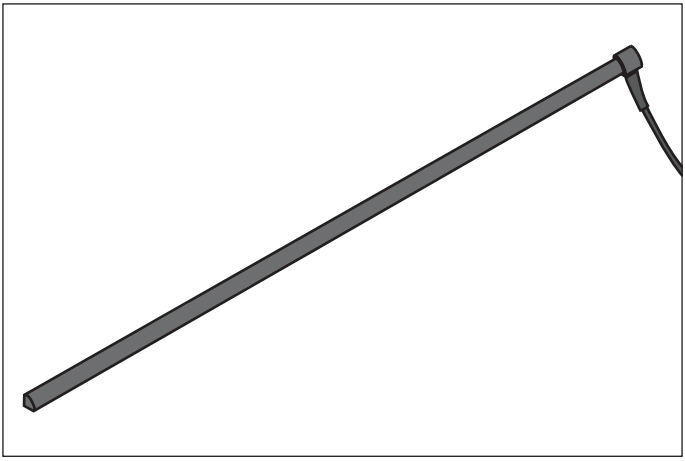
Ensure you lift the probe vertically. Off-vertical force can damage the probe.

Extraction Using Multi-Grips or Vice-Grips

If a probe removal tool is not available, multi-grips or vice-grips can be used for extraction. The method and precautions are the same as that for extraction using a probe removal tool (see above).

Hint: To avoid damage to the probe body, cushion the jaws of the multi-grips or vice-grips with heavy-duty heatshrink, electrical or duct tape, or rubber.

AquaCheck Sub-surface Probe



AquaCheck probes provide reliable soil moisture, and temperature measurement in all soil types. Multiple sensor clusters per probe allow the monitoring of moisture and temperature at each sensor depth. Soil moisture readings are temperature-compensated.

The internal electronics are fully protected, making the probes reliable, consistent and very stable.

Each probe is supplied with 5 m of cable. Designed to be completely buried, the AquaCheck is 'out of the way' when slashing, spraying and harvesting.

Moisture profiling at 100 mm intervals allow you to track the movement of water through the root zone and optimise irrigation events. Following the movement of nutrients through the root zone by tracking changes in salinity allows you to optimise fertiliser applications and only apply leaching irrigations when needed.

AquaChecks can be used with:

- Plexus for continuous monitoring and the display of data on smart devices.
- MAX for continuous monitoring and viewing of data on a PC.

Which Probe to Use

The choice of probe will be determined by the depth of the root zone or profile depth to be monitored.

'Standard' sensor depths for the sub-surface model as at July 2014 are listed in the table below.

	Probe Model			
	60 cm	80 cm	100 cm	120 cm
Sensor Depths (cm)	10	10	10	20
	20	20	20	40
	30	30	40	60
	40	40	60	80
	50	60	80	100
	60	80	100	120

Sensor Site Selection

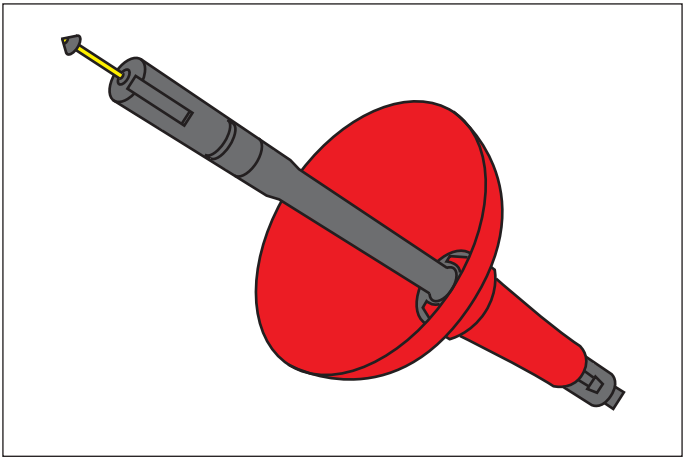
Please see "Sensor Site Selection" on page 9. Although this section deals with the placement of gypsum blocks under different types of irrigation, the considerations apply equally well to AquaCheck probes.

How to Install AquaChecks

The tools, methods and considerations for the installation of AquaCheck probes are the same as those for EniviroPro probes.

Please refer to "EnviroPro" on page 26.

FullStop Wetting Front Detectors



The FullStop provides a cost effective method of assessing whether too much or too little irrigation is being applied, to detect water logging and to monitor nutrient and salt levels in the soil.

The heart of the FullStop is a funnel shaped collector which is buried in the soil. As moisture moves through the soil profile (a wetting front), it converges in the funnel and collects in a reservoir in the base of the unit.

An indicator flag is fitted to an extension tube which protrudes above ground. When water collects in the base of the funnel, floats within the extension tube cause the indicator flag to pop up to show that the wetting front has arrived. The indicator flag is held up with a magnetic latch and must be pushed down to reset it. If the soil is still very wet, the flag will pop up again. An outlet tube at the base of the FullStop allows water collected in the funnel to be extracted using a syringe, and tested for EC and nitrate levels.

Unlike the other sensors in this guide, the FullStop requires no power source, Readers, Loggers or software.

Sensor Site Selection

FullStops are sold and generally used in pairs, with one unit at one third of the root depth, and the second at two thirds of the root depth.

Drip Irrigation

- The detector must always be placed directly under a dripper. Suggested depth for the shallow detector is 30 cm and for the deep detector is 60 cm.
- Deeper placement is required for widely spaced drippers or long irrigation intervals. Shallower placement suits closely spaced drippers, frequent irrigation or shallow rooted crops.
- It is common for detectors to respond quickly under drip because all the water is being concentrated around the dripper, with dry soil between drippers. In such cases less water should be applied more often.

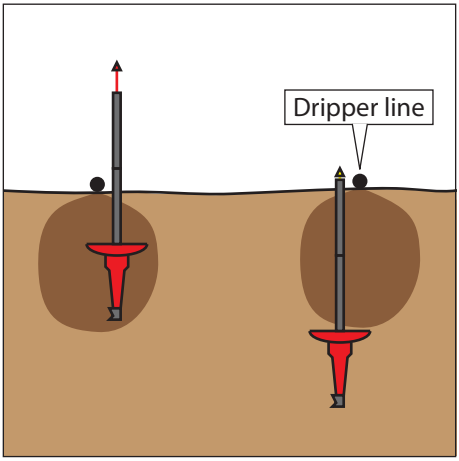


Fig. 41. A pair of FullStops under drippers.

Sprinkler or Microjet Irrigation

- Wetting patterns tend to be shallower under sprinkler irrigation than drip or furrow irrigation.
- Suggested depth for the shallow detector is 20 cm and for the deep detector is 40 cm. Note that it usually takes 20 mm or more of irrigation to activate a detector at 20 cm (depending on soil type and on how dry the soil is before irrigation).
- For sprinkler systems that apply small amounts of water each day or second day (e.g. microjets or centre pivot), depths of 15 cm and 30 cm are more suitable (5 cm and 20 cm to the rim of the funnel). Detectors will usually not be activated by applications under 15 mm, unless the soil is quite wet before irrigation.

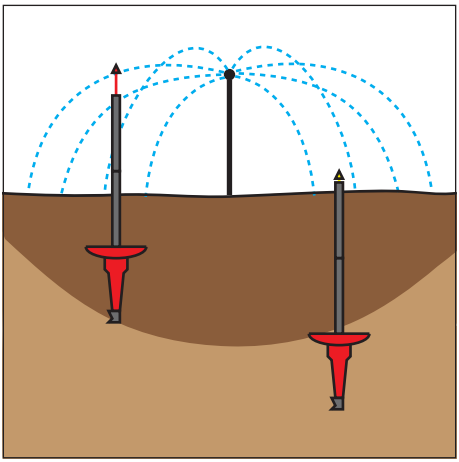


Fig. 42. A pair of FullStops under sprinkler irrigation.

Furrow Irrigation

- Detectors should be positioned half under the furrow and half under the bed with the extension tube rising through the shoulder of the bed.
- Suggested depth for the shallow detector is 20 ~ 30 cm and for the deep detector is 40 ~ 60 cm (from the base of the furrow). Deep rooted crops with less frequent irrigation would require deeper placement.

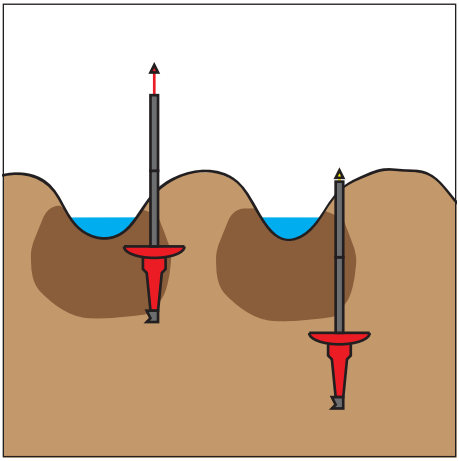


Fig. 43. FullStops under furrows.

Required Tools and Equipment

- 20 cm and 5 - 10 cm augers (or shovel and trowel if you don't have access to the augers)
- Tape measure.
- Portable EC Meter (MEA2272) for monitoring salinity levels
- Nitrate and nitrite test strips (MEA2273 and MEA2274) for monitoring nutrient levels

How to Install FullStops

Following are instructions for installing the FullStops using augers.

Hint: If you do not have the required augers, a shovel can be used instead of the larger auger, and a trowel instead of the small auger.

1. Assemble and test the FullStops according to the instructions that came with them. Check for leaks, and make sure the float indicator can move freely through the extension tube(s). Attach as many extension tubes as required for the installation depth.
2. Make a hole with the large Auger. This will accommodate the wide part of the funnel.

Hint: If the soil texture changes with depth, keep the different soil layers separate.

3. When the hole is deep enough, use the small Auger to make a hole for the bottom of the FullStop.
4. Add the filter sand (supplied with the FullStops) to the detector until it covers the locking ring by at least 1 cm.

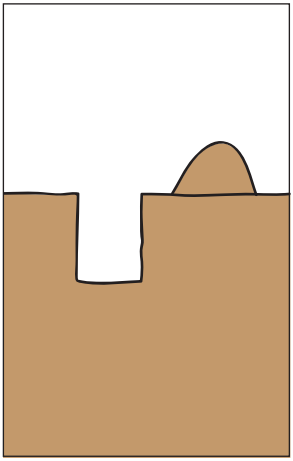


Fig. 44. Dig the large hole.

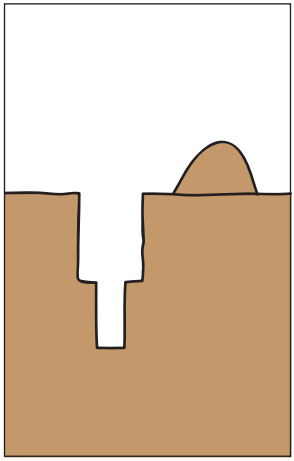


Fig. 45. Dig the small hole.

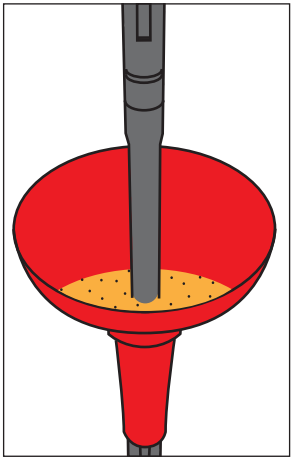


Fig. 46. Add the filter sand to the funnel.

5. Place the detector in the hole and measure the distance to the rim of the funnel to check that it reaches the required depth.
6. Make sure the extension tubes are vertical.
7. Fill the funnel with soil from the same layer, and lightly firm it down.
8. Break up the sides of the hole before returning more soil, as smooth sides can restrict the growth of roots and the movement of water.
9. Pack soil around the sides and under the funnel to keep it firmly in place (hold the outlet tube out of the way) - the deeper narrow hole does not need to be packed with soil.

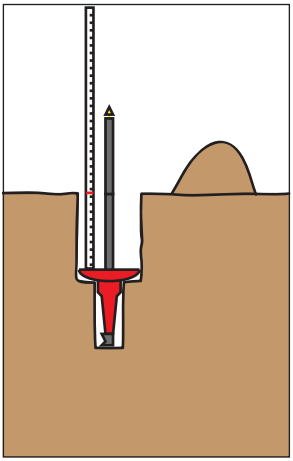


Fig. 47. Check the depth.

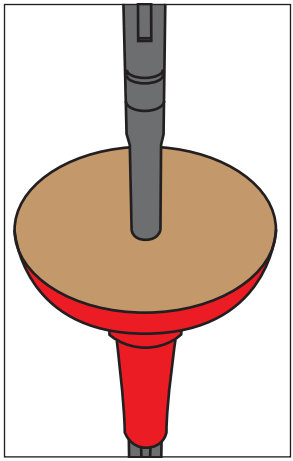


Fig. 48. Fill the funnel with soil.

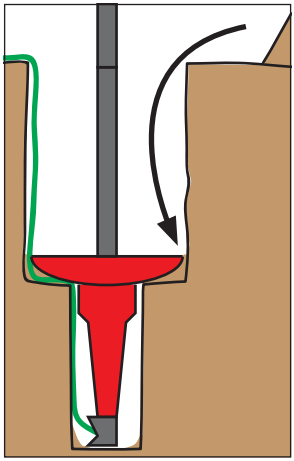


Fig. 49. Pack under the funnel with soil.

10. Return the rest of the soil to the hole in the layer order in which it was extracted.
11. Soil should be firmed down by hand, but not compacted.
12. Use the trowel to break up the top edge of the hole.
13. All the soil should be returned to the hole, leaving a slight 'hump' which should settle after rain or irrigation. After settling, check that the soil is level so that water does not run away from or toward the detector.
14. Push the tubing stake (supplied with the FullStop) into the end of the outlet tube (this will prevent insects and soil from entering and blocking the tube) and use it to position the tube away from the detector.

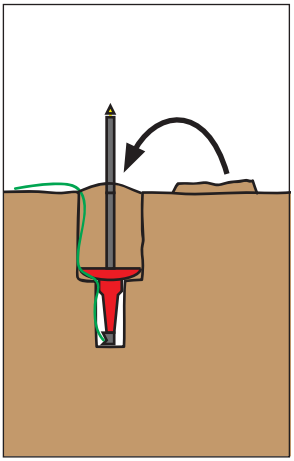


Fig. 50. Backfill the hole.

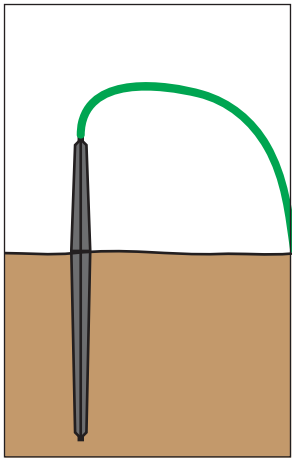


Fig. 51. Fit the tube to the tubing stake.

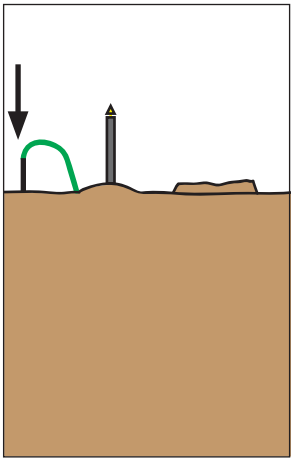
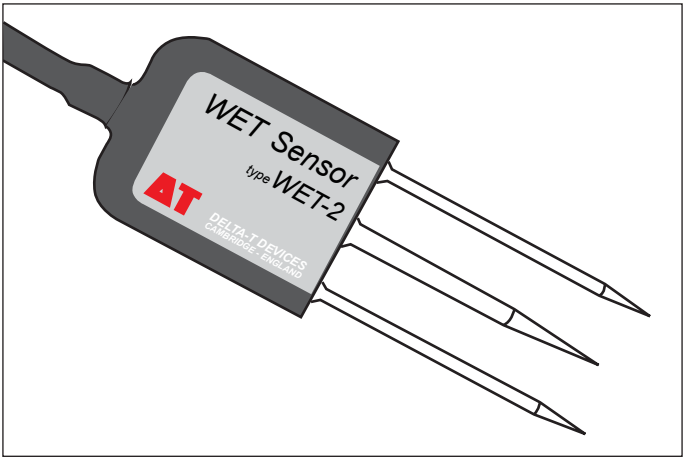


Fig. 52. Install the tubing stake.

For more information please visit **www.fullstop.com.au**

WET Sensors



The WET Sensor measures water content, electrical conductivity, and temperature in soils, composts and other artificial growing media.

In five seconds the probe can provide a measure of water content over the range of 0 to 80%, pore-water conductivity from 0 to 600 $mS.m^{-1}$, and temperature over the range of 0 to 40°C.

The WET sensor is used with:

- HH2 Reader, which needs to be loaded with the sensor's unique calibration. Data can be viewed on the Reader and downloaded to a computer.

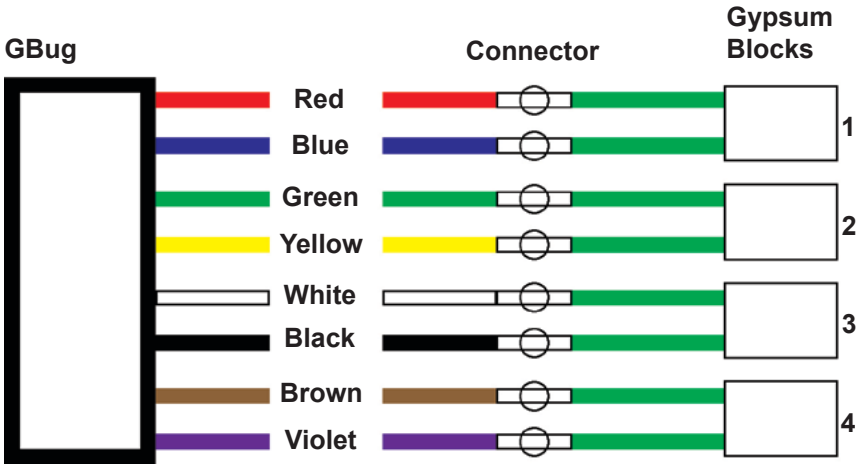
How to Install WET Sensors

If the WET sensor is to be installed in a fixed location, remember that although the sensor housing is waterproof, *the connector used to attach it to a HH2 Reader is not*. You will have to find some means of ensuring that water does not enter the connector.

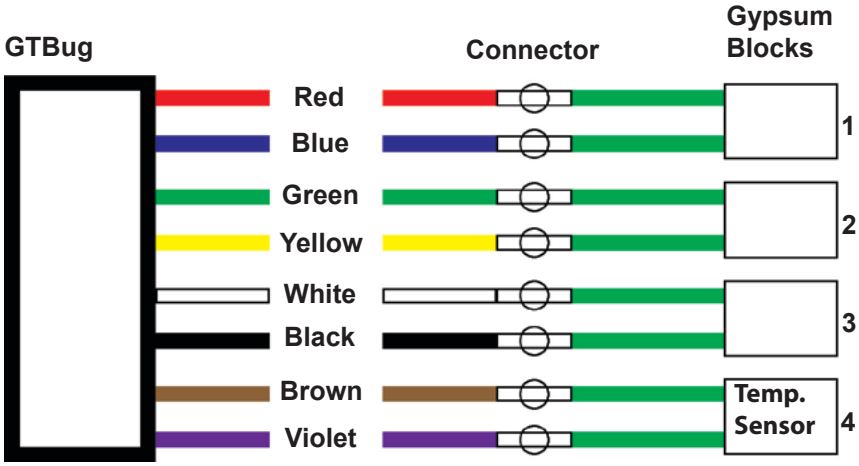
Installation equipment, procedures and considerations are the same as for ThetaProbes. Please see *"ThetaProbes" on page 18,* or refer to the WET User Manual.

Wiring Guides

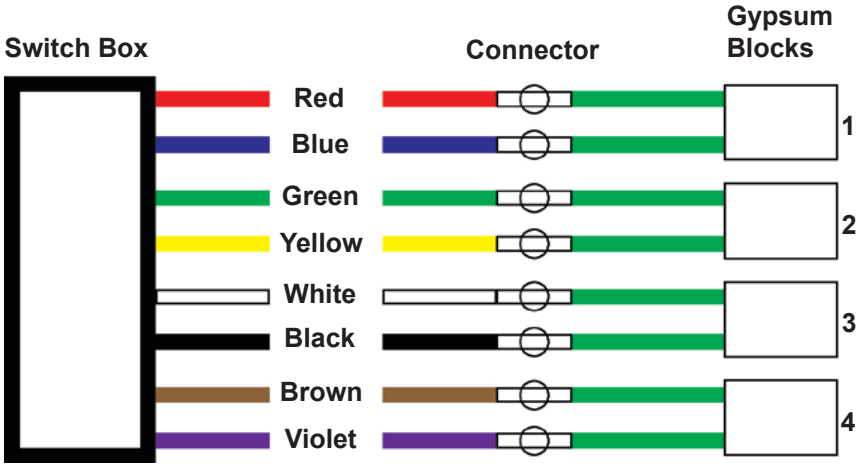
GBug Wiring Diagram



GTBug Wiring Diagram



GDot Switch Box Wiring



ThetaProbe Wiring

4 Pin Connector	Function	Colour
1	Signal	Yellow
2	Signal Ground	Green
3	Power Ground	Blue
4	Power Supply	Red

EnviroPro Wiring

Function	Plexus* Cable	EP (pre Oct. 2013)	EP (post Oct. 2013)
+12V	Red	Brown	Red
Data	Blue	Blue	Blue
GND	Green	Green/Yellow	Black
not used	Yellow	-	Yellow

* To connect an EnviroPro to systems other than Plexus, please consult the User Manual or wiring diagram that came with your system.

AquaCheck Wiring

Function	Plexus* Cable	AquaCheck
+12V	Red	Brown
Data	Blue	Blue
GND	Green	Green/Yellow
not used	Yellow	-

* To connect an AquaCheck probe to systems other than Plexus, please consult the User Manual or wiring diagram that came with your system.